The Effect of English Language Proficiency on Length of Stay and In-hospital Mortality

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BACKGROUND: **In ambulatory care settings, patients with limited English proficiency receive lower quality of care. Limited information is available describing outcomes for inpatients.**

OBJECTIVE: **To investigate the effect of English proficiency on length of stay (LOS) and in-hospital mortality.**

DESIGN: **Retrospective analysis of administrative data at 3 tertiary care teaching hospitals (University Health Network) in Toronto, Canada.**

PARTICIPANTS: **Consecutive inpatient admissions from April 1993 to December 1999 were analyzed for LOS differences first by looking at 23 medical and surgical conditions (59,547 records) and then by a meta-analysis of 220 case mix groups (189,119 records). We performed a similar analysis for in-hospital mortality.**

MEASUREMENTS: **LOS and odds of in-hospital death for limited English-proficient (LEP) patients relative to English-proficient (EP) patients.**

RESULTS: **LEP patients stayed in hospital longer for 7 of 23 conditions (unstable coronary syndromes and chest pain, coronary artery bypass grafting, stroke, craniotomy procedures, diabetes mellitus, major intestinal and rectal procedures, and elective hip replacement), with LOS differences ranging from approximately 0.7 to 4.3 days. A meta-analysis using all admission data demonstrated that LEP patients stayed 6% (approximately 0.5 days) longer overall than EP patients (95% confidence interval, 0.04 to 0.07). LEP patients were not at increased risk of in-hospital death (relative odds, 1.0; 95% confidence interval, 0.9 to 1.1).**

CONCLUSIONS: **Patients with limited English proficiency have longer hospital stays for some medical and surgical conditions. Limited English proficiency does not affect in-hospital mortality. The effect of communication barriers on outcomes of care in the inpatient setting requires further exploration, particularly for selected conditions in which length of stay is significantly prolonged.**

KEY WORDS: **administrative database; English proficiency; in-hospital mortality; length of stay; patient care.**
J GEN INTERN MED 2004;19:221–228.

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In many North American and European countries, a significant minority has limited proficiency in the dominant language, and this minority is growing. According to the 2000 U.S. Census, approximately 17.6% of Americans speak a language other than English in their homes. Of these, 19.5 million (almost half) are unable to speak English "very well," representing a 42.3% increase from 1990.[1] Similar trends have been reported in the United Kingdom and Canada.[2,3] Despite growing multilingualism in these regions, the effect of limited English proficiency on health care outcomes has received little research attention.

In the health care setting, language discordance occurs when a patient has limited proficiency in the language(s) spoken by health care providers. Previous studies in the outpatient setting have shown that language discordance may result in poorer quality of care, worse outcomes, and decreased satisfaction.[4–8] The effect of language discordance on health outcomes in medical and surgical inpatients has not been evaluated.

Approximately 1.7 million (37%) of Toronto's 4.5 million people are from visible minorities, with South Asians (28%), Chinese (24%), African Americans (18%), and Filipinos (8%) comprising the greatest proportion. Fifteen percent of residents speak a language other than English or French (Canada's official languages) in their homes, and 39% have a mother tongue other than English or French. Immigrants to Canada comprise 44% of the population of Toronto, with Asia, Europe, and the Caribbean accounting for the largest proportion.[9]

Our objective was to determine whether limited English-proficient (LEP) patients stay longer in hospital or have increased in-hospital mortality rates than English-proficient (EP) patients, using data from 3 hospitals in Toronto.

DESIGN AND METHODS

We performed a retrospective analysis of inpatient visits at 3 hospitals between April 1, 1993 and December 31, 1999. The Toronto General, Toronto Western, and Princess Margaret hospitals (University Health Network; UHN) are tertiary care teaching centers with a total of 860 beds. Two administrative databases were used: the UHN electronic patient information system (containing language information) and the Canadian Institute for Health Information (CIHI) discharge abstract database. Length of stay (LOS), discharge disposition, diagnosis codes, procedure codes, and case mix groups (CMGs), the Canadian equivalent of diagnosis-related groups, are found in discharge abstracts.[10,11] The data sets were linked using the medical record number and discharge date to identify unique hospitalizations.

Language Data and Validation

Upon admission to any of the 3 hospitals, a clerk assesses whether a patient is able to communicate in English and enters this into the electronic patient information system. These data were used to dichotomize patients into EP and LEP groups. We excluded records with missing data, and those where both English and another language were recorded. Language data were independently validated by a research assistant via direct interview of 280 hip fracture patients.[12] We found 88% agreement between the interviewer and the database with a κ statistic of 0.69 (95% confidence interval [CI], 0.60 to 0.79), indicating substantial agreement.[13]

Selection of Medical and Surgical Conditions

We used International Classification of Diseases, Ninth Revision (ICD9) diagnosis codes and Canadian Classification of Procedures (CCP) procedure codes to create groups of patients admitted for similar conditions. For example, patient records with ICD9 codes 431, 433, 434, or 436 as the most responsible diagnosis were grouped as "stroke." Selection criteria for ICD9 codes associated with 6 medical conditions and 2 surgical conditions were taken from the Ontario Hospital Association's Hospital Report 2000.[14] Our study group (11 internists) chose additional conditions based on the most frequent diagnoses, procedures, and CMGs at our institution. We reviewed published literature and established selection criteria for each condition using a consensus process (see Appendix).

We identified "index admissions" by excluding readmissions occurring within 1 year for the same diagnosis. For medical conditions, we excluded cases in which the most responsible diagnosis was also coded as a complication, as this indicates that the condition developed after admission of the patient to hospital. For surgical conditions, we excluded records where the most responsible diagnosis code indicated that no procedure was performed (V641, V642, V643). We excluded records with no postal code (used to impute socioeconomic status). We also excluded hip fracture cases less than 45 years of age in order to exclude hip fractures in younger persons arising after severe trauma. For the LOS analysis, we excluded patients who died, were transferred to or from another acute care facility, or signed out against medical advice.

Risk-adjustment Models

We derived 3 risk-adjustment measures from the data set: the Charlson comorbidity score (categorized as 0, 1, ≥2), adapted for use with ICD9 diagnosis codes,[15,16] the number of comorbid diagnoses present on admission,[17] and imputed income, estimated from place of residence (postal code) and census data.[18,19]

We developed a regression model to adjust for LOS differences between EP and LEP patients, using a subset of 10 conditions (out of a total of 23) with a large number of hospitalizations (Appendix). The distribution of LOS values was skewed and therefore the logarithm of LOS was modeled as the dependent variable. Model selection was based on the change in estimate method.[20,21] The variables included based on consistent findings across these 10 conditions were English proficiency status, age, gender, UHN hospital site of discharge, fiscal year, Charlson comorbidity score, number of comorbid diagnosis codes, marital status, and income quintiles. The regression model was used to estimate the effect of limited English proficiency on LOS for all 23 medical and surgical conditions.

We adjusted baseline risk for in-hospital mortality between English proficiency groups using binary logistic regression. We developed a risk-adjustment model using a subset of 7 (out of 13) conditions (Appendix). Due to constraints imposed by the limited number of deaths for some conditions, we chose a parsimonious model that included English proficiency, age, and Charlson score. The regression model was used to estimate the effect of limited English proficiency on in-hospital mortality for 13 medical and surgical conditions. For both the LOS and in-hospital mortality analyses, risk-adjustment models were applied to groupings of ICD9 diagnosis codes and CCP codes chosen to represent the same underlying medical or surgical condition. For example, stroke hospitalizations were identified by one of several ICD9 codes (Appendix).

We performed a global test of interactions.[22] Global interactions improved the fit of the length of stay model in 7 of 23 conditions. Global interactions improved the fit of the in-hospital mortality model in 2 of 13 conditions. For each condition, we reviewed individual interactions between the English proficiency variable and each variable in the risk-adjustment model. By consensus judgment of the investigators, none of the interactions represented a consistent effect of sufficient magnitude to necessitate inclusion in the risk-adjustment models.

Outcome Measures

The outcomes were the relative LOS of LEP patients compared to EP patients (23 conditions), and the odds of death of LEP patients relative to EP patients (13 conditions). Relative LOS was estimated by taking the antilog of the regression coefficient for LEP. After analysis using our initial risk-adjustment models, we tested explanatory hypotheses and adjusted for the number of procedures, the number of days until the primary procedure, and the number of in-hospital complications. We decided *a priori* that the additional variable would be considered an explanatory variable if, upon addition to the model, it changed the estimate of relative LOS by 10% or more.[21]

In order to evaluate the consistency of our results, we used an alternative modeling strategy in which all confounding variables were collapsed into a single adjustment variable known as the propensity score.[23]

Meta-analysis Using Case Mix Groups

Case mix groups are assigned to each record in the database based on diagnosis codes, complications, and procedure codes.[10,11] We grouped patients by CMG in order to include more records than our initial analysis of medical and surgical conditions. As a result, instead of evaluating the effect of English proficiency only in selected medical and surgical conditions, we analyzed all admissions grouped into CMGs. We applied our risk-adjustment models to CMGs, treating each CMG as a separate study, to obtain independent risk-adjusted estimates of the effect of English proficiency. We excluded CMGs with fewer than 200 patients, fewer than 10 patients per English proficiency group (LOS analysis), and fewer than 6 deaths per English proficiency group (in-hospital mortality analysis).

Our meta-analysis used Bayesian random-effects models[24] to calculate summary estimates of the relative LOS and the odds ratio for in-hospital mortality at UHN during the study period. Our Bayesian random-effects model generated both an estimate for the overall mean of the group of CMG-specific estimates as well as "shrunken" estimates for individual CMGs. Case mix group-specific estimates are adjusted or "shrunken" toward the overall mean by amounts that are proportional to their variances.

For unadjusted analyses, categorical variables were compared using a χ^2 test, and continuous variables using an independent sample's t test. We used a single sample binomial test to determine whether the proportion of conditions (or CMGs) with significant differences favoring one group was greater than what would be expected by chance. Statistical analyses were performed using SPSS for Windows, Release 9.0.0 (SPSS Inc., Chicago, Ill), and WinBUGS, Version 1.2 (MRC Biostatistics Unit, Cambridge, UK).[25]

Research Ethics

The research protocol was approved by the UHN Research Ethics Board.

RESULTS

Our primary analysis of 23 medical and surgical conditions included 59,547 records, representing 44,983 patients. LEP patients were older, more often female, and had lower imputed income values and higher comorbidity scores (Table 1). The Toronto Western hospital had a significantly larger proportion of LEP patients than the other hospitals in the study. The 10 languages most frequently spoken by inpatients are also reported.

Table 1. Baseline Characteristics of the Length of Stay Cohort (*N* = 44,983)

Characteristics	Limited English-Proficient (*N* = 6,124)	English-Proficient (*N* = 38,859)	*P* Value
Mean age, y	66.7	60.2	<.001
% Female	50.6	38.6	<.001
No. of comorbid diagnosis codes, %			
0	16.5	20.3	
1	19.0	23.4	
2	19.1	20.1	
≥3	45.4	36.2	<.001
Charlson score, %			
0	55.2	61.9	
1	13.1	15.1	
≥2	31.7	23.0	<.001
Marital status, %			
Married	71.4	68.4	
Single	25.2	27.4	
Unknown	3.4	4.1	<.001
Quintiles of imputed individual income, %†			
1	39.5	17.5	
2	22.6	19.2	
3	18.2	20.1	
4	12.2	21.2	
5	7.5	22.0	<.001
Hospital site, %			
Toronto General Hospital	60.4	42.9	
Toronto Western Hospital	38.9	56.6	
Princess Margaret Hospital	0.7	0.5	<.001
Language, %*			
English	0.0	100.0	
Portuguese	26.0		
Italian	20.0		
Chinese (Mandarin, Cantonese)	18.7		
Greek	5.8		
Polish	4.1		
Spanish	4.1		
Vietnamese	2.4		
Ukrainian	1.8		
Punjabi	1.6		

** Only the top 10 languages are recorded.*
† 1 = lowest quintile.

Table 2 shows the unadjusted mean LOS. Adjusted results are reported as the LOS of LEP patients relative to EP patients. Limited English-proficient patients stayed significantly longer than EP patients in 7 (30%) of the 23 medical and surgical conditions; 3 of 13 medical conditions (unstable coronary syndromes and chest pain, diabetes mellitus, and stroke), and 4 of 10 surgical conditions (coronary artery bypass grafting, craniotomy procedures, elective hip replacement, and major intestinal and rectal procedures). This result is significant ($P < .001$); we would expect a maximum of only 2 conditions to have statistically significantly longer LOS for LEP patients by chance alone if there were no true effect for any of the conditions. Moreover, in none of

Table 2. Unadjusted and Adjusted Length of Stay by English Proficiency Status

Medical and Surgical Conditions	*N* LEP/EP	Unadjusted Mean Length of Stay (days)		Adjusted Relative Length of Stay† (days)	
		LEP	EP	LEP/EP‡	(95% CI)
Unstable coronary syndromes & chest pain	1,502/16,484	6.9	5.0	1.29*	(1.23 to 1.34)
Coronary artery bypass grafting	586/7,559	12.7	10.3	1.07*	(1.03 to 1.12)
Acute cholecystitis	766/2,371	4.1	3.1	1.05	(0.99 to 1.12)
Prostatectomy	362/2,634	9.6	7.0	1.02	(0.93 to 1.11)
Stroke	644/2,294	26.1	14.9	1.29*	(1.18 to 1.42)
Craniotomy procedures	248/2,498	14.4	10.1	1.15*	(1.02 to 1.31)
Hysterectomy	346/2,216	6.3	6.5	0.97	(0.92 to 1.02)
Heart failure	666/1,688	9.6	10.8	0.95	(0.87 to 1.03)
Community-acquired pneumonia	623/1,538	7.8	9.0	0.95	(0.87 to 1.03)
Diabetes mellitus	272/1,797	11.6	7.3	1.28*	(1.13 to 1.45)
Acute myocardial infarction	478/1,485	12.9	11.9	1.07	(0.98 to 1.15)
Major intestinal & rectal procedures	265/1,461	14.9	12.8	1.10*	(1.02 to 1.19)
Cirrhosis	215/1,082	8.2	8.9	0.94	(0.82 to 1.08)
Elective hip replacement	108/1,068	11.3	9.2	1.13*	(1.03 to 1.23)
Gastrointestinal hemorrhage	285/828	6.7	6.7	1.00	(0.89 to 1.12)
Chronic obstructive pulmonary disease	275/807	8.1	8.3	1.08	(0.95 to 1.23)
Bowel obstruction	205/836	7.0	7.5	1.06	(0.92 to 1.22)
Major head & neck procedures	67/842	11.0	10.8	0.93	(0.73 to 1.19)
Hip fracture	236/649	18.9	19.9	0.98	(0.88 to 1.09)
Acute diverticulitis	54/400	7.0	7.7	1.02	(0.82 to 1.27)
Elective abdominal aortic aneurysm repair	19/409	9.5	10.1	1.00	(0.84 to 1.20)
Asthma	81/225	6.0	5.9	1.11	(0.88 to 1.40)
Ruptured abdominal aortic aneurysm	3/70	27.3	18.5	1.46	(0.48 to 4.45)

* $P \leq .05$.

† *Risk-adjustment variables include English proficiency status, age, gender, hospital site of discharge, fiscal year, marital status, Charlson comorbidity score, number of comorbid diagnoses, and quintiles of individual imputed income.*

‡ *Estimates represent the length of stay for LEP patients relative to EP patients.*

LEP, limited English-proficient patients; EP, English-proficient patients; CI, confidence interval.

the conditions examined did LEP patients have statistically significantly shorter adjusted LOS than EP patients.

We predicted mean LOS (on the original scale) for 2 typical patients differing only by English proficiency status, using Duan's smearing estimator. Predicted numbers of days for the significant conditions (EP, LEP patients) are as follows: unstable coronary syndromes (3.9, 5.0), diabetes (6.4, 8.2), stroke (12.1, 15.7), coronary artery bypass grafting (8.4, 9.0), craniotomy procedures (6.8, 7.9), elective hip replacement (7.5, 8.5), and major intestinal and rectal procedures (10.5, 11.5).

Further exploratory analyses showed that the effect of English proficiency on LOS changed only minimally after adjustment for the total number of procedures, the number of days until the first procedure, or the number of in-hospital complications (results not shown).

The unadjusted rates and adjusted odds of in-hospital mortality are reported in Table 3. Overall, no clear pattern emerged as LEP patients had greater odds of death for craniotomy procedures and ruptured abdominal aortic aneurysm, but lower odds for acute myocardial infarction.

The propensity score models yielded results similar to our principal risk-adjustment models, with the 95% CIs of the estimates produced using both strategies showing a large degree of overlap (results not shown).

There were 269,845 inpatient visits in our data set assigned to 476 different CMGs, but only 220 CMGs representing 189,119 hospitalizations (70.1% of all hospitalizations) met inclusion criteria for the LOS meta-analysis. Of this group, 50 (22.7%) showed significant LOS differences; 41 (18.6%) with increased LOS for LEP patients and 9 (4.1%) with increased LOS for EP patients.

A funnel plot of the estimates of relative LOS for individual CMGs is shown in Figure 1, with the CMGs arranged by decreasing sample size. The estimates are scattered around a value greater than 1, suggesting that LEP patients stay longer. The degree of scatter increases with decreasing sample size, indicating that the precision of the estimates is lower when sample size is smaller. We found no pattern indicating that relative LOS varied according to whether a CMG was medical or surgical (results not shown). A histogram of the Bayesian random-effects estimates of relative LOS for all 220 CMGs also shows that the mean of the distribution is greater than 1 (Fig. 2). The summary estimate of LOS for LEP patients relative to EP patients is 1.06 (95% CI, 1.04 to 1.07). Although this estimate is based on 220 of 476

Table 3. Unadjusted and Adjusted Odds Ratio of In-hospital Mortality by English Proficiency Status

Medical and Surgical Conditions	*N* LEP/EP	Unadjusted In-hospital Mortality Rate (%) LEP	EP	Adjusted Odds Ratio of In-hospital Death† LEP/EP‡	(95% CI)
Unstable coronary syndromes & chest pain	1,740/21,388	1.9	1.1	1.12	(0.77 to 1.62)
Coronary artery bypass grafting	746/10,767	4.0	2.3	1.43	(0.97 to 2.11)
Craniotomy procedures	344/3,102	10.8	4.4	1.98*	(1.34 to 2.94)
Stroke	782/2,813	14.5	10.7	1.23	(0.97 to 1.56)
Heart failure	730/1,980	7.1	8.0	0.73	(0.53 to 1.02)
Community-acquired pneumonia	701/1,801	10.3	10.7	0.77	(0.58 to 1.03)
Acute myocardial infarction	597/2,576	12.9	13.3	0.72*	(0.55 to 0.95)
Major intestinal & rectal procedures	280/1,601	3.6	4.6	0.60	(0.30 to 1.19)
Cirrhosis	246/1,321	7.7	9.0	0.71	(0.42 to 1.19)
Chronic obstructive pulmonary disease	287/892	3.8	4.8	0.57	(0.29 to 1.14)
Gastrointestinal hemorrhage	317/943	7.6	5.4	1.15	(0.68 to 1.93)
Hip fracture	252/719	4.8	6.0	0.66	(0.33 to 1.30)
Ruptured abdominal aortic aneurysm	10/135	70.0	25.2	7.34*	(1.65 to 32.67)

* $P \leq .05$.
† *Risk-adjustment variables include English proficiency status, age, and Charlson comorbidity score.*
‡ *Estimates represent the odds of death in-hospital for LEP patients relative to EP patients.*
LEP, limited English-proficient patients; EP, English-proficient patients; CI, confidence interval.

CMGs, the total proportion of inpatient visits represented is high (70.1%).

Only 43 CMGs representing 56,994 hospitalizations and 5,287 deaths met the inclusion criteria for the in-hospital mortality meta-analysis. Ten had significant results; 5 (11.6%) showed LEP patients with greater odds of in-hospital death and 5 (11.6%) in the opposite direction (Fig. 3). The overall result for LEP versus EP patients is 1.00 (95% CI, 0.88 to 1.14).

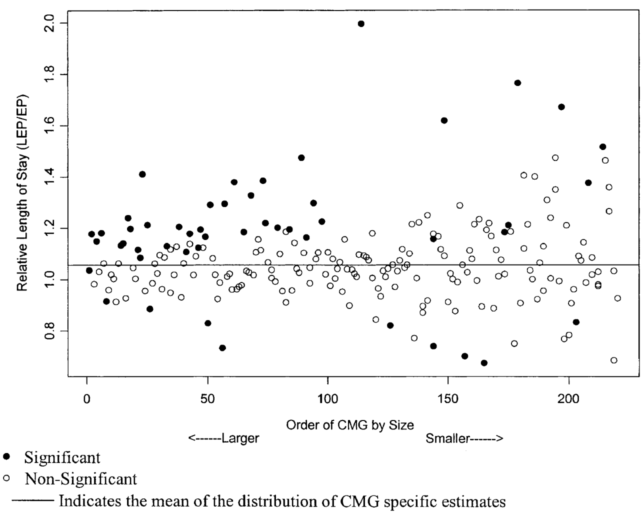

FIGURE 1. Adjusted relative length of stay by CMG (CMG ranked by sample size).
CMG, case mix group; LEP, limited English-proficient patients; EP, English-proficient patients.

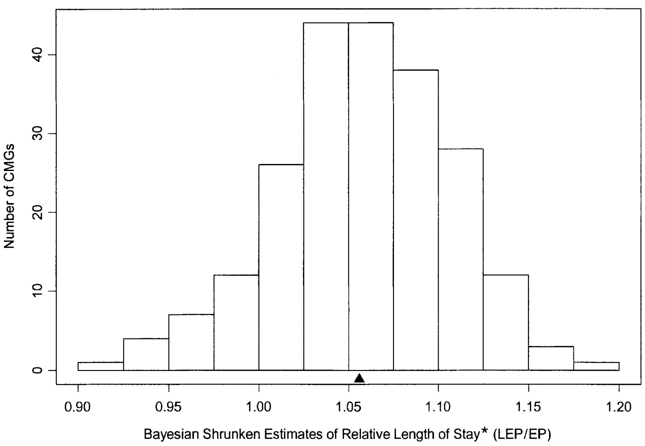

FIGURE 2. Histogram of the relative length of stay estimates for each case mix group. *Derived using Bayesian random-effects meta-analysis of the adjusted estimates for each CMG (risk-adjustment variables include English proficiency status, age, gender, hospital site of discharge, marital status, Charlson comorbidity score, number of comorbid diagnoses, and quintiles of individual imputed income). ▲ Indicates the mean of the distribution.
CMG, case mix group; LEP, limited English-proficient patients; EP, English-proficient patients.

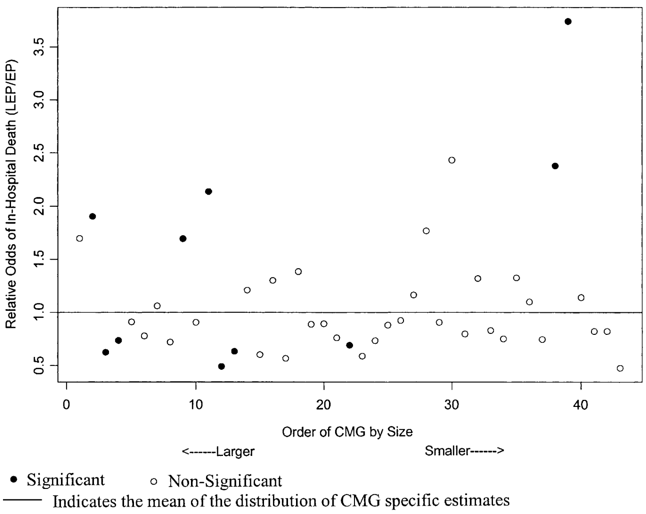

FIGURE 3. Adjusted odds ratio of in-hospital mortality by CMG (CMG ranked by sample size).
CMG, case mix group; LEP, limited English-proficient patients; EP, English-proficient patients.

DISCUSSION

Our study demonstrates that LEP patients stay 6% (approximately 0.5 days) longer overall than EP patients. A 6% difference in LOS is modest in comparison to studies looking at the association between LOS and outcomes[26] or interventions to shorten LOS,[27] which demonstrate effect sizes of 1 to 6 days. However, the aggregate result from our meta-analysis of CMGs does not reflect larger differences at the level of individual diagnoses. The effect of English proficiency on LOS is greater for conditions such as stroke (additional 3.6 days) and diabetes mellitus (1.8 days). English proficiency had no effect on in-hospital mortality.

Our study adds to a growing body of evidence that limited English proficiency may have adverse effects on health outcomes. Language discordance is associated with poorer quality of care, including inadequate use of analgesia for pain control in an emergency,[28] poorer evaluation and management of gallstones,[29] decreased use of preventive services such as mammography[4] and cervical cancer screening, and worse functional status.[30] Patients with language discordance had longer emergency department stays, underwent more diagnostic tests,[8] and were less likely to be referred for follow-up appointments.[5] Language discordance is also associated with dissatisfaction with health care for both physicians[6] and patients.[7,31] Our study demonstrates that English proficiency may have an impact on inpatient LOS.

Prolonged LOS suggests that processes of care may be altered when a patient has limited English proficiency. In addition to patient characteristics (e.g., age, gender), processes of care determine length of hospital stay.[32] Using the database, we were unable to identify specific processes or outcomes of care (i.e., complications, number of procedures, and time to procedure) that accounted for the observed differences. Another possible interpretation of our result is that the quality of inpatient care for LEP patients may have been compromised as it is in the outpatient setting, leading to longer recovery times and prolonged LOS. Inadequate outpatient care may prolong inpatient LOS by increasing the number of medical issues that need to be addressed by caregivers. The finding that limited English proficiency did not affect in-hospital mortality implies that the in-hospital care of these patients was sufficient to prevent increased risk of in-hospital death. Perhaps long-term mortality after hospital discharge might be increased if patients with limited English proficiency had fewer follow-up appointments[5] and felt confused about discharge instructions.[7]

Individual data on interpretive services are not routinely recorded in the available databases. Aggregate data indicate that for the year 2000, a total of 10 professional interpreters provided services in Portuguese, Italian, Spanish, Vietnamese, Cantonese, and Mandarin. Language services received over 4,000 requests for interpretation, of which approximately 3,600 were filled. Limited English-proficient patients may not have experienced language discordance if communication aids such as hospital or family interpreters and multilingual caregivers were present, as these aids should mitigate the effect of LEP on language discordance. Although existing communication aids introduce a bias toward observing no difference between English proficiency groups, communication aids may also lead to longer lengths of stay if such services take time to obtain.

Length of stay is extensively used as an administrative outcome to assess the efficiency of hospital care delivery.[33] The incremental cost of a hospital day has been estimated at $680 U.S. dollars.[34] Therefore, costs attributable to a 0.5-day overall increase in LOS can be substantial and the cost of care for LEP patients may be increased, this increment being higher for conditions such as stroke and diabetes mellitus.

The validity of our result depends on the adequacy of adjustment for patient characteristics that affect LOS. Our risk-adjustment model included comorbidity scores, age, gender, marital status, and socioeconomic status. We also confirmed our result using multiple analytic methods. However, it is still possible that residual confounding played a role, because disease severity and comorbidity are not fully captured in administrative data. Factors we were unable to test for included race/ethnicity (which are not routinely recorded in admissions to Canadian hospitals), availability of interpreters, problems with discharge planning, medication errors, adverse drug reactions, and inadequate pain control. Dichotomous coding of data on English proficiency represents a potential limitation. English proficiency lies along a continuum and the classification of a patient as LEP involves a subjective cut point. However, no realistic alternative was available and the strong results of our validation study show that the dichotomous classification is reproducible and captures a general notion of what it means to have limited English proficiency.

We demonstrated that limited English proficiency may prolong length of stay, but has no effect on in-hospital mortality. Additional studies are required to confirm the effect of English proficiency on health outcomes, and to explore the mechanisms by which this effect is mediated. Expanding immigration rates from non-English-speaking regions along with the aging of elderly immigrants who have never acquired English proficiency suggest that the health consequences and economic impact of language discordance should be better explored and understood, so that methods for mitigating these effects can be found.

This research was supported by the University Health Network General Internal Medicine Clinical Research Fund. Ara John-Baptiste is supported by a Canada Graduate Scholarship from the Canadian Institutes of Health Research. Gary Naglie was partially supported by the Mary Trimmer Chair in Geriatric Medicine Research from the University of Toronto.

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Appendix

Criteria for the Selection of Medical and Surgical Cases

Medical Conditions	International Classification of Diseases, Ninth Revision (ICD9) Selection Codes
Acute cholecystitis	574.0, 574.1, 574.3, 574.4, 575.0, 575.1
Acute diverticulitis	562.0, 562.1
Acute myocardial infarction*†‡	410
Asthma‡	493
Bowel obstruction	560, 5500, 5501, 551, 552
Chronic obstructive pulmonary disease	490, 491, 492, 496
Cirrhosis	571.2, 571.5, 571.6, 572.2, 572.3, 572.4, 572.8, 567.0, 456.8, 789.5
Community-acquired pneumonia*†‡	481, 482, 485, 486
Diabetes mellitus	250
Gastrointestinal hemorrhage‡	531.0, 531.2, 531.4, 531.6, 532.0, 532.2, 532.4, 532.6, 533.0, 533.2, 533.4, 533.6, 534.0, 534.2, 534.4, 534.6, 578
Heart failure†‡	428, 415.0, 416.9
Stroke*†‡	431, 433, 434, 436
Unstable coronary syndromes & chest pain*†	411, 412, 413, 414, 786.5
Surgical Conditions	**Canadian Classification of Procedures (CCP), Case Mix Groups (CMGs), and International Classification of Diseases Ninth Revision (ICD9) Selection Codes**
Coronary artery bypass grafting*†	CCP 48.1
Craniotomy procedures*†	CMG 1
Elective abdominal aortic aneurysm repair*	CCP 50.24, 50.34 & ICD9 441.3
Elective hip replacement*	CCP 93.5, 93.6
Hip fracture	ICD9 820
Hysterectomy*‡	CCP 80.2, 80.3, 80.4, 80.5, 80.6
Major head & neck procedures	CMG 76
Major intestinal & rectal procedures	CMG 253
Prostatectomy*‡	CCP 72.1, 72.2, 72.3, 72.4, 72.5
Ruptured abdominal aortic aneurysm	CCP 44.14

* *Used in developing the length of stay risk-adjustment model.*
† *Used in developing the in-hospital mortality risk-adjustment model.*
‡ *Selection criteria taken from the Ontario Hospital Association's Hospital Report 1999.*[14]